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An Examination of the Use of Supervised Machine Learning Algorithms in Education

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Abstract

Background: In a world where technology is evolving day by day, machine learning can bring huge changes to our daily lives. This technology is used not just in technical sectors but also in non-technical ones. The capacity of a machine to enhance its own performance is referred to as "machine learning".
Objectives: The machine is essentially designed to learn by making mistakes. Machine learning algorithms are one of the best ways to improve the educational system.
Methods / Statistical Analysis: Numerous daily-used applications, including facial recognition, spam filtering, and online shopping recommendations, are powered by machine learning algorithms. The use of machine learning in education can be useful for both teachers and students. This paper is a study on supervised machine learning algorithms such as linear regression, logical regression, and decision trees.
Findings: We did a case study using the linear regression algorithm in order to understand students better. Further, we also found the advantages of using machine learning in the education system and the challenges faced in implementing machine learning.
Applications / Improvements: However, implementing this practically may be time-consuming, but with fast-growing technology, this can become easy.

Key words: Supervised Learning, Algorithms, Linear regression, Logical regression, Decision Tree, Flowchart.

1. Introduction

The model is trained using supervised learning on a specific dataset. This specific dataset is also known as a "labelled dataset," which consists of both input and output data. Here, the input is denoted by ‘xi’ and the output is denoted by ‘yi’. The output variable is always dependent on the input variable. Further, the model analyses this data and predicts the output depending on the new input. In this type of learning, there is always a supervisor who monitors the output produced by the model and gives feedback accordingly; this feedback is then taken by the machine depending on which model is updated. The supervisor can be an error function, a loss function, or an objective function.

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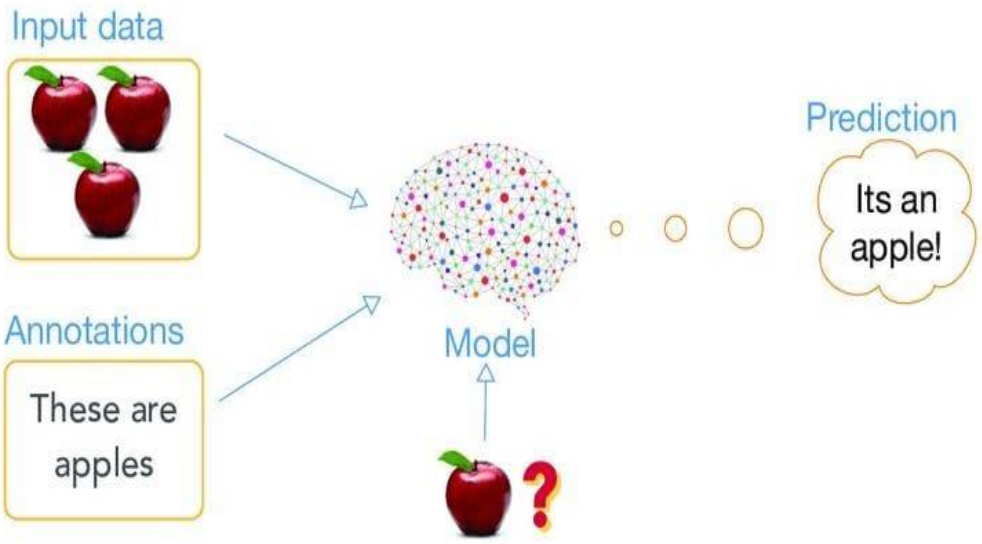

Figure 1. Supervised Learning

2. Algorithms Used in Supervised Learning

Linear Regression

A method known as "linear regression" uses an equation to represent the relationship between a dependent variable and one or more independent variables. Based on the known value of the independent variable, it can be used to forecast the value of the dependent variable. Also, it may identify a straight line that closely resembles a group of points on a graph. This algorithm is used when the input variable and output variable have a linear relationship; this can be known by using "scatter plot".

There are two types of linear regression, namely:

1. Simple Linear
2. Multiple Linear

Simple Linear Regression

In this type of linear regression, there is only one independent and dependent variable, which can be represented using the following equation.

$$y = \alpha_0 + \alpha_1 x_1$$

'**y**' refers to the dependent or output variable.
'α_0, α_1' refers to the co-efficient of regression.
'x_1' refers to a single independent variable.
Therefore, this equation can be written as
'$y = c + mx'$, where 'm' is the scope of a line and 'c' is an intercept.

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Multiple Linear Regression

If a linear regression has more than one independent or dependent variable, it is termed a "multiple linear regression". This can be represented using the following equation:

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 \ldots\ldots + \alpha_m x_m$$

'**y**' refers to the dependent or output variable.
'α_i' refers to the co-efficient of regression.
'x_i' refers to a single independent variable.

Any variable having the highest alpha value determines that particular variable is most important for calculating accurate output.

Flow Chart

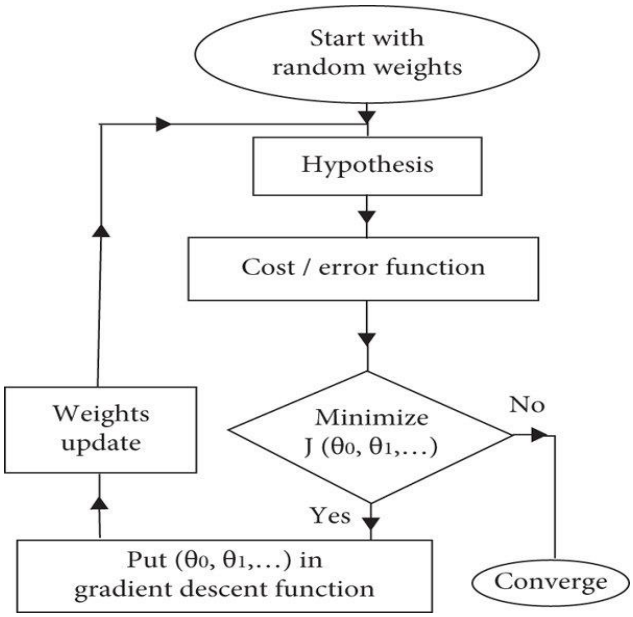

Figure 2. Flowchart for Linear Regression

Logistic Regression

It is used for solving classification problems. It forecasts a dependent variable's outcome that is categorised. As a result, the output must be a continuous or categorised value. Rather than providing the exact values of 0 and 1, it provides the probabilistic values that fall between 0 and 1. It can be either Yes or No, 0 or 1, true or false, etc. This algorithm is represented by the following equation:

$$y = 1/1 + e^{-x}$$

'x' refers to an independent variable.

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This equation is known as the "sigmoid function". As a result of this function, the independent variable is converted into an expression of probability ranging from 0 to 1 based on the dependent variable.

Flow Chart

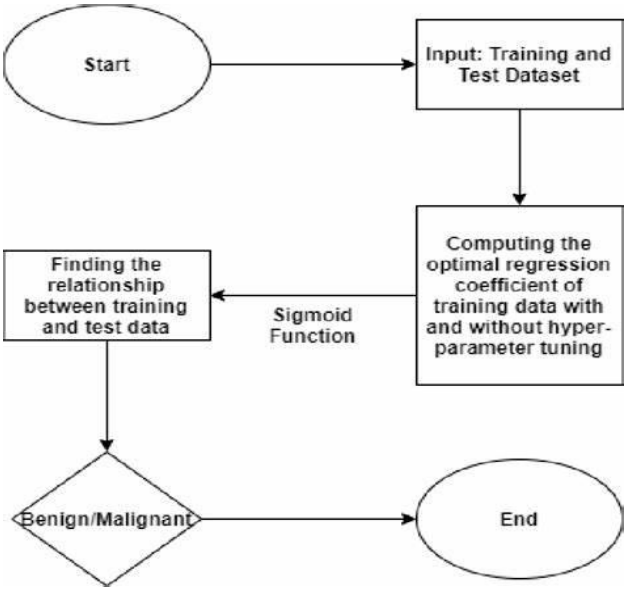

Figure 3. Flowchart for Logistic Regression

Decision Tree

This algorithm can be used for both classification and regression. In the technique of classification, it acts as a "classifier", where a dataset is given to the algorithm, and further, the algorithm generates a model or a classifier that is in a tree structure. When an unknown input is given to this model, it classifies the input into a particular group. These trees structure two nodes, namely the "Decision Node" and the "Leaf Node". Each leaf node represents the result, branches stand for the decision-making processes, and internal nodes reflect the dataset's features. The decision node represents a test whose results can either be Yes or No. Following are the steps involved in the standard formula of the decision tree:

- Identify the issue that has to be resolved and the variables that are important.
- Collect information on the factors that will influence decisions.
- List the variables that require prediction.
- Separate the data into testing and training sets.
- Determine whether to create a decision tree using an algorithm or a model.
- Use a testing set to evaluate the decision tree's accuracy.
- Removing unused branches or nodes will increase accuracy.
- Use the decision tree to make predictions using new data.

3. Benefits of Using Machine Algorithms in Education

The use of machine learning in education enhances teaching and learning procedures in a number of ways. Due to the numerous advantages of using machine learning in education,

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experts believe that machine learning will play a bigger role in the education sector over the upcoming years. A few of these advantages include the following:

Expanded access to online education globally

It can be expensive to translate eLearning courses and individual assets (video lectures, eBooks, discussion forums, etc.) into several languages. In order to translate and transcribe content rapidly, precisely, and affordably, machine learning programmes can be used in educational settings.

Higher-performing courses

A course can be customised to meet individual needs thanks to predictive analytics. Machine learning can be used to identify skill gaps and give particular content to learners based on their performance. The amount of time spent on each segment and the level of involvement with the course contents are two more metrics that learners can view. This guarantees that ML-based courses outperform conventional, one-size-fits-all courses in terms of efficiency and effectiveness.

Reduced administrative work

Many administrative and management tasks, such as onboarding, scheduling, giving instructions, monitoring attendance, and grading assignments, can be carried out automatically by machine learning-based eLearning courses. This gives educators more time to devote to tasks that are more imaginative, subjective, and human-centred.

Individualised learning paths

The uniformity of the curriculum is one drawback of traditional teaching methods. Different people learn differently, and similar approaches favour some learning styles while disadvantaging others. Differentiated instruction is made possible by machine learning systems, where instruction is customised for the needs of each unique student. This spares teachers the additional labour required to accomplish this manually while still enabling them to offer targeted, personalised learning pathways.

More rapid research

Departments of research in higher education greatly benefit from machine learning. There are numerous implications for the discovery and administration of research depositories from the deep data science capabilities (for instance, text mining) of ML systems.

4. Challenges in Implementing Machine Learning in Education

As more and more students, teachers, and administrators rely on technology to support learning, implementing machine learning into current educational systems is becoming ever more important. However, there are difficulties involved in adding machine learning to these systems.

Complex Algorithms

The incorporation of complex algorithms into current systems Since machine learning algorithms are frequently complicated, it can be challenging to incorporate them into current

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educational systems. This is especially true for older systems that may not work with the newest algorithms because they have been in place for a long time.

Expensive

Since most educational systems already have limited resources, adding machine learning to existing systems might not be financially feasible. Additionally, the price of upgrades and maintenance may be too high.

Designing Algorithms

Creating algorithmic solutions that are suitable for the educational system can also be a challenge. Not all machine learning algorithms are appropriate for all systems and circumstances used in education. For a successful integration, it is crucial to create algorithms that are specifically suited to the requirements of the educational system.

Training

Training teachers and administrators to employ machine learning in the classroom is a challenge. Even though many educators are familiar with conventional teaching techniques, they might not possess the same level of expertise when it comes to machine learning. It can be expensive and time-consuming to train them to apply machine learning successfully.
Major challenges can arise when integrating machine learning into current educational systems. These difficulties can be overcome, though, with proper planning and design. Organisations can assure the successful integration of machine learning into their current educational systems by understanding the difficulties involved.

5. Case Study: Better Prediction with Basic Data by Utilizing Machine Learning Algorithms

Technology is now moving to the next level, giving machines human intelligence, which makes it simpler for machines to understand real-world problems and learn on their own using machine learning algorithms by analysing the given data and matching patterns. This can be integrated with the current education system to create a better education system.

Table 1. Attendance vs. Average Score

OVERALL_ATTENDENCE	TOTAL_MARKS_ORIGINAL	TOTAL_MARKS_PREDICTED
75.0	85.0	85.825285142
72.0	85.0	84.415049622
87.0	92.0	91.466227225
95.0	98.0	95.226855280

- In our case study, we wanted to learn more about students and the reasons why so many of them fall behind. We used various datasets to take into account factors like student

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attendance and average scores. Where it was observed that attendance is an independent variable while grades are a dependent variable.

The following were the results after the case study:

- It was found that the students who had attendance of more than 80% scored up to 95%.
- We also found that students who have attendance less than 80% have scored in the range of 65%–70%.

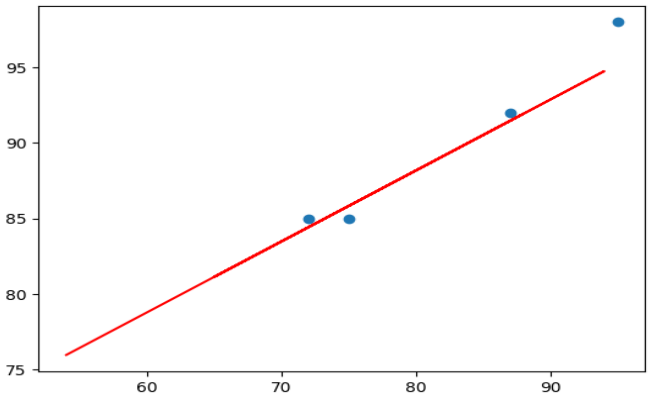

Figure 4. Accuracy Result

The above graph shows the accuracy of this algorithm. As all the data points are close to the plotted line, it indicates that the algorithm has high accuracy. When calculated, this algorithm had an accuracy of 92%.

In order to improve students' academic performance, educational institutes have to make it mandatory for the students to attend the classes and have attendance of more than 80%, and they should take strict action against students who have less attendance.

6. Conclusions

As technology advances daily, many new developments are made, and soon all work will be carried out by machines. A nation's population can be knowledgeable in both theory and practise when technology is integrated into the educational system. By understanding students and assisting them in accordance with their needs, teachers and students can benefit from the application of machine learning in education by simplifying the learning process. However, integrating machine learning technology into the classroom can be very challenging. Every technology has benefits and drawbacks, but with careful planning and efficient technological utilisation, the disadvantages can often be overcome. Additionally, there is a significant amount of research required to implement machine learning in education.

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